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ABSTRACT

The promotion of scientific literacy has become an important goal for science education, and the ability to negotiate socioscientific issues is at least one aspect of scientific literacy. This paper focuses on how the moral dimensions of socioscientific issues influence decision-making regarding these issues. Morality is examined from multiple perspectives including the cognitive-developmental model and affective approaches. The paper reviews theoretical and empirical literature regarding the role of affect in moral decision-making scenarios and concludes that moral emotions can exert considerable influence on an individual's negotiation of moral issues including socioscientific issues. Empathy and other emotions can guide issue construal, which determines whether an individual engages in moral reasoning, or, in some cases, can serve as the primary factor determining action or behavior. The evidence suggests an inseparable link between moral decision-making and affect. Because socioscientific issues inherently involve moral considerations, affect is a significant component in the negotiation and resolution of these issues. If the goal of science education is the promotion of scientific literacy and scientific literacy involves the negotiation of socioscientific issues, then science educators must attend to emotional factors when designing science curricula because of the central role emotions play in shaping socioscientific decisions. (Contains 71 references.) (Author)

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Socioscientific Issues and the Affective Domain: Scientific Literacy's Missing Link

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ABSTRACT. The promotion of scientific literacy has become an important goal for science education, and the ability to negotiate socioscientific issues is at least one aspect of scientific literacy. This paper focuses on how the moral dimensions of socioscientific issues influence decision-making regarding these issues. Morality is examined from multiple perspectives including the cognitive-developmental model and affective approaches. The paper reviews theoretical and empirical literature regarding the role of affect in moral decision-making scenarios and concludes that moral emotions can exert considerable influence on an individual's negotiation of moral issues including socioscientific issues. Empathy and other emotions can guide issue construal, which determines whether an individual engages in moral reasoning, or, in some cases, can serve as the primary factor determining action or behavior. The evidence suggests an inseparable link between moral decision-making and affect. Because socioscientific issues inherently involve moral considerations, affect is a significant component in the negotiation and resolution of these issues. If the goal of science education is the promotion of scientific literacy and scientific literacy involves the negotiation of socioscientific issues, then science educators must attend to emotional factors when designing science curricula because of the central role emotions play in shaping socioscientific decisions.

Socioscientific Issues and the Affective Domain:

Scientific Literacy's Missing Link

The phrase 'scientific literacy' has garnered a great deal of attention from the science education community for at least the past decade. This has been a significant period in the history of science education because of the advent of standards documents (American Association for the Advancement of Science (AAAS), 1990, 1993; National Research Council (NRC), 1996) and sustained reform efforts geared towards promoting the vision of science teaching and learning articulated in these reports. Although the AAAS and the NRC standards and objectives are not identical, they do complement one another. In general, both guidelines argue for the promotion of scientific literacy for all students. In short, the documents which guide science education reform offer the promotion of scientific literacy as the primary goal of science educators at every level.

The architects of modern science education reform did not coin the phrase 'scientific literacy'; in fact, it has appeared in the literature for almost fifty years. Paul Hurd is credited with first publishing the phrase in 1958, but the notion that underlies scientific literacy for all citizens can be traced back to at least the beginning of the century (Laugksch, 2000). Despite (or maybe because of) the fact that scientific literacy has been a part of the landscape of science education for a considerable length of time, its meaning remains marred in debate. Some authors suggest that disputes surrounding the meaning of scientific literacy have left it an ill-defined and diffuse concept of little practical value (Champagne & Lovitts, 1989; Laugksch, 2000). However, a rational analysis of the goals described in the reform documents and the needs of current elementary and secondary science students can provide a conceptualization of scientific literacy that is both meaningful and valuable (DeBoer, 2000).

Science for All Americans, the first of the reform reports, defined scientific literacy as a multifaceted construct including the following elements:

> being familiar with the natural world and respecting its unity; being aware of some of the important ways in which mathematics, technology, and the sciences depend upon one another; understanding some of the key concepts and principles of science; having a capacity for scientific ways of thinking; knowing that science, mathematics, and technology are human enterprises, and knowing what that implies about their strengths and limitations; and being able to use scientific knowledge and ways of thinking for personal and social purposes. (AAAS, 1990, pp. xvii-xviii)

The *National Science Education Standards* defines a scientifically literate person as someone who is able to 'use appropriate scientific processes and principles in making personal decisions' and 'engage intelligently in public discourse and debate about matters of scientific and technological concern' (NRC, 1996, p. 13). Both of these conceptualizations characterize scientific literacy as an active objective; they provide benchmarks for using scientific knowledge and processes. A logical question to ask in response to this analysis is use of knowledge and processes towards what end? In answering this question, it is important to remember the documents' intended foci. We need look no further than the title of one, *Science for All Americans* (AAAS, 1990), and the opening sentence of the other, 'scientific literacy has become a necessity for everyone' (NRC, 1996, p. 1). Scientific literacy is not a goal restricted to the academically elite or those who show the promise of becoming tomorrow's scientists, doctors, and engineers; scientific literacy is for every student. If this is the case, then scientific literacy cannot involve the level of technical sophistication required by particle physicists, molecular

biologists, and chemical engineers. Most students will not become professional scientists and engineers and therefore will not need to master the specifics of the de Broglie hypothesis, posttranslational protein regulation, or any number of other science discipline-specific information. In fact, most professional scientists probably do not even understand intra-discipline complexities beyond their own specialties (Pool, 1991); it seems ridiculous to expect student scientific literacy to eclipse that of practicing scientists.

What then do all students actually need to be able to do in order to achieve scientific literacy? They need to be able to use scientific processes and habits of mind to solve problems faced in everyday life and to confront issues that involve science and make informed decisions (Kolstø, 2001a; Driver, Newton, & Osborne, 2000; Patronis, Potari, & Spiliotopoulou, 1999). Science pervades nearly all aspects of modern society and in order to ensure the proper functioning of such a society within the context of democracy, its citizens must be capable of considering and resolving scientific issues. In support of this contention, consider the science-related issues of crucial import as evidenced by their prominence in political campaigns, media reports, and personal decisions. A small sample of these issues include cloning, stem cell research, alternative fuels, global warming, ozone depletion, nuclear energy, and genetically modified foods. Because the class of scientific issues that requires public input (as opposed to the realm of scientific issues faced by professional scientists) necessarily involves societal factors, these issues have been termed socioscientific issues (Kolstø, 2001a; Zeidler, Walker, Ackett, & Simmons, 2002). At least one component of scientific literacy must be the ability to negotiate socioscientific issues and produce informed decisions.

Socioscientific decision-making can be influenced by a number of factors including informal reasoning and argumentation (Zohar & Nemet, 2002; Driver et al., 2000; Patronis et al.,

1999), conceptualizations of the nature of science (Bell & Lederman, in press; Zeidler et al., 2002; Sadler, Chambers, & Zeidler, in press), the ability to evaluate evidence (Kolstø, 2001b; Tytler, Duggan, & Gott, 2001; Korpan, Bisanz, Bisanz, & Henderson, 1997), conceptual understanding related to the underlying content (Fleming, 1986b; Kolstø, 2001a; Hogan, 2002), and moral and ethical considerations (Zeidler, 1984; Zeidler et al., 2002; Pedretti, 1999). Of the influences just described, the final is perhaps the most contentious suggestion for inclusion in science curricula. Strategies for dealing with ethical dilemmas are typically not associated with the canon of elementary or secondary school science. However, past and current curricular sparsity is not an appropriate rationale for excluding ethics and morality in the future. Ethics and morality are inseparable from science in the context of socioscientific issues, and forced attempts to compartmentalize science and ethics should be avoided. Learning experiences that do not address the moral and ethical dimensions of socioscientific issues present students with a partial view of reality and fetter their ability to participate in discussions concerning these matters. Consider the issue of genetically modified foods (GMF). International scientific, business, agricultural and political communities are currently embroiled in debate over the status and accepted uses of animal and plant crops which have been genetically altered. Ethical ramifications associated with producing, marketing, and consuming genetically modified foods as well as the policies which regulate these practices abound (Pence, 2002; Nottingham, 1998; Charles, 2001). Some questions raised by the ethical components of this issue include the following. Should organisms be unnaturally altered by gene replacements or additions? Will genetically modified crops impact natural populations of organisms? Can individuals and/or corporations patent genes? Do farmers have the right to raise crops of their choice? Can genetically modified foods reduce worldwide hunger? Do consumers have a right to know if

products have been genetically altered? Should manufacturers be forced to divulge information that will adversely affect their business? These comprise a small sample of the many ethical concerns central to the GMF debate, and decisions made without considering these kinds of questions are necessarily limited. These are obviously difficult issues with which to deal making the need for their inclusion in the treatment of socioscientific issues and scientific literacy great. Individual socioscientific issues may vary in the extent to which ethics and morality impact decision-making, but most possess an ethical dimension. It is extremely likely that this trend will only increase as molecular genetics and other biotechnologies flourish, alternative fuel searches continue, and environmental concerns increase.

Frameworks for Investigating Morality and Ethics

The GMF example offered above provides a description of some of the moral and ethical considerations inherent to socioscientific dilemmas. The notion that the negotiation of socioscientific issues involves moral considerations has been supported empirically by studies which have explored influences on student decision-making regarding socioscientific issues (Zeidler & Schafer, 1984; Pedretti, 1999; Fleming, 1986a; Bell & Lederman, in press). These studies have documented that students do, in fact, incorporate moral considerations in their decision-making; however, the question of how morality contributes to socioscientific decision-making remains unanswered. Although this particular question has not been the subject of intense research in the field of science education, moral philosophers and psychologists have devoted considerable efforts to closely related issues. Modern conceptualizations of morality and its impact on decision-making can be traced to Piaget (1948), who laid the groundwork for the cognitive-developmental approach to morality. This tradition, which was formalized and expanded by Kohlberg and his followers, centered on moral reasoning and moral principles,

most notably principles of justice. Given this approach, educators might expect individuals to relate to socioscientific issues in terms of moral principles. However, subsequent researchers have questioned the cognitive-developmentalists' singular focus on moral reasoning and have suggested refinements that place more emphasis on other aspects such as affective and emotive concerns. In the sections that follow, the cognitive-developmental approach will be described followed by an elaboration of the alternative frameworks, based on affect, that have emerged in response to some of the criticisms levied against the former. These affective frameworks will be explored in an effort to reveal a more holistic understanding of the factors that influence how individuals make decisions regarding socioscientific issues.

The Cognitive-Developmental Approach

Lawrence Kohlberg's influential work serves as the cornerstone of the cognitive-developmental approach to moral reasoning (Oser, 1996). Kohlberg, inspired by Piaget's theory of cognitive development and work on morality as well as Kantian justice principles, proposed a set of six culturally universal and invariant stages through which people proceed in moral development. The stages are subsumed by three, more general levels: preconventional (stages one and two), conventional (stages three and four), and postconventional (stages five and six). Each level defines the manner in which a person reasons about moral issues, and they proceed from heteronomy to autonomy. In stage one, children make decisions in order to avoid punishment. Stage two is characterized by the preservation of one's own needs and interests. In the conventional level, moral agents begin to respect and seek to protect social norms and expectations. Stage three individuals attempt to conform to their perceived roles and judge others with these stereotypical criteria. Stage four is an extension of the former in that agents have supreme respect for authority, fixed rules and social order. The postconventional level

marks the first deviation from imposed morality; individuals consider values and principles apart from social institutions. In stage five, agents negotiate issues by examining individual rights and contractual obligations. Stage six, which is rarely achieved and difficult to operationalize, is characterized by self-chosen ethical principles that satisfy comprehensiveness, universality, and consistency (Kohlberg, 1973; 1985).

Subsequent research (Thoma & Rest, 1999; Walker & Taylor, 1991) has produced a model of stage progression. Development occurs through a series of alternating phases of consolidation and transition. During transition, individuals display inconsistency resulting from a mixture of reasoning modes. An individual in transition employs reasoning from both the stage at which they have been most recently situated as well as the next stage into which they will develop. Consolidation marks the period following transition during which the individual's mode of reasoning becomes more consistent. During consolidation, reliance on reasoning strategies other than those which typify the agent's current stage is minimized. For example, a stage three individual would show minimal evidence of stage two reasoning and virtually no evidence of stage four reasoning. Longitudinal studies based on Kohlbergian methodologies such as interviews employing moral dilemmas and the Defining Issues Test (DIT) (Rest, 1975) support the model of consolidation and transition. The researchers contend that the longitudinal nature of the studies validate their conclusions (Walker & Taylor, 1991). However, the instruments used in these evaluations create a potential problem: Kohlbergian dilemmas and the DIT are constructed to identify stage patterns but do not reveal other factors that could contribute to the subjects' responses.

Whereas empirical evidence supports an agent's ability to apply moral reasoning when answering questions about a moral dilemma, the transfer of moral reasoning to behavioral

choices is far more infrequent. Kohlberg's theory predicts a consistency of reason and action not revealed in empirical studies (Carpendale, 2000). It was long assumed that an agent who consistently applies stage five reasoning to dilemmas would choose behaviors that reflect his reasoning; however, the assumption is predicated on the idea that behavior is affected only by formalized reasoning. If factors other than reasoning impact moral behavior, then the proposed, direct link between Kohlbergian developmental stages and behavior is inaccurate (Emler, 1996). No contemporary research supports the assertion that behavior directly follows reasoning. This does not necessarily mean that moral development does not occur via stages, nor does it imply that moral reasoning has no relationship to decision-making or conduct (Arnold, 2000). However, the discrepancy between moral reasoning and behavior provides evidence for the influence of 'non-reason' based factors.

Neo-Kohlbergian psychologists (Thoma & Rest, 1999; Rest, Narvaez, Bebeau, & Thoma, 1999; Narvaez, 1998; Rest, 1975), who have been influenced by and have built upon the work of Kohlberg, proposed a new model of morality that addressed some of the major philosophical and psychological criticisms of the former approach. These researchers have suggested that individuals progress through moral schemas rather than stages. Whereas stages are strictly defined and discontinuous, schemas are less rigid and can overlap. The neo-Kohlbergians propose three developmental schemas that generally correspond to the preconventional, conventional, and postconventional levels of Kohlbergian development: personal interest schema, maintaining norms schema, and the postconventional schema. Although the reasoning strategies evident in the complimentary groupings are similar, the new model postulates and includes several differences. Development results from changes in the frequency of strategies used rather than the invariant progression of set stages. The neo-Kohlbergians recognize the

importance of dilemma content and context in shaping responses and behavior. They also drop the claim of cultural universality. Morality emerges from a social setting; therefore, it must, in some ways be bound to that culture. Individual communities may posses their own moral principles and norms, but this does not have to imply complete moral relativism. Individuals must negotiate their own decisions and actions not completely free of any standards but subject to the community they help make. The new model also acknowledges the important difference between reasoning in a contrived context such as a testing situation and decision-making in actual events (Rest, Narvaez, Thoma & Bebeau, 2000).

Affective Approaches

Gilligan's Critique

Gilligan (1982) offered one of the first critiques of the Kohlbergian model by citing a masculine bias in the formulation and description of cognitive-developmental theory. Although subsequent work included females, Kohlberg's original sample, upon which his theory of moral development was based, included only males. Gilligan argued that the absence of the female voice skewed the theoretical underpinnings of moral development. Support for this claim came from the relative absence of female postconventional moral thinkers as determined by Kohlbergian interview studies. Significantly fewer women attained stage 5 or 6 designation in the justice-based coding scheme than their male counterparts (Hekman, 1995). Because Kohlberg's scheme is hierarchical in nature and presupposes developmental superiority of higher stages (Kohlberg, 1973), the necessary conclusion from the under-representation of postconventional females is a gender-based inadequacy. It is interesting to note that similar problems with the cognitive-developmental framework have been recognized with other groups not represented in Kohlberg's original study such as agrarian communities and tribal societies

(Snarey, 1985). A complete discussion of these issues is beyond the scope of this presentation other than to suggest that women are not the only group to be labeled morally underdeveloped by this theory.

Gilligan found the moral inferiority hypothesis to be untenable and began investigating alternatives to the justice as morality dogma which dominated the field. She talked with women who were contemplating abortion about their decision-making with respect to this issue as well as the formal dilemmas used in the Kohlbergian moral interviews. Based on this work, Gilligan postulated revisions to the cognitive-developmental framework. She concluded that moral reasoning is not necessarily beholden to the principle of justice; that is, equally valid reasoning can be based on ethics other than justice. The women in her study were able to make sophisticated moral judgments comparable to the universalizable standards that described postconventional stages, but the participants were more interested in relational issues and caring for other individuals than they were in justice considerations. Gilligan characterized this alternative focus the ethic of care and concluded that Kohlberg's scheme underrepresented women as mature moral thinkers not because of some gender-based inadequacy but rather, because of a limited theoretical and methodological perspective. Kohlberg's moral interview could not account for the application of an ethic of care as opposed to justice and therefore misrepresented the moral development of women (Gilligan, 1982).

Gilligan's contention that men and women reason differently has been the subject of much criticism. Research that has made direct comparisons of male and female moral reasoning, an analysis that that neither Kohlberg's or Gilligan's seminal, theory-forming work could do because of restricted samples, presents mixed conclusions. Some studies report a distinction in male and female moral decision-making (Ford & Lowery, 1986; Donenberg & Hoffman, 1988);

whereas, others fail to find any significant differences (Cohn, 1991; Thoma, 1986). However, the trend in empirical findings suggests that men and women apply principles of both justice and care in the midst of moral decision-making (Tronto, 1987; Friedman, Robinson, & Friedman, 1987; Singer, 1999; Hekman, 1995). Gilligan's work is significant, at least in part, because it broadened the scope of moral psychology (Hekman, 1995). She challenged the paradigm of justice-based morality, and in doing so forced the field to examine alternative influences. Although her system still involved cognitive reasoning, Gilligan opened the door to the affective domain because of the central role emotions play in the ethic of care. Subsequent work has seized the opening to conceptualize a framework of morality entirely distinct from the cognitive-developmental approach.

A Working Taxonomy of Affect

The term 'affect' and the various synonyms associated with it such as 'feelings', 'emotion', 'mood', 'passions', and 'sentiment' can assume a myriad of meanings to diverse audiences. This paper is chiefly concerned with the constructs found within this range that influence the resolution of moral quandaries, particularly socioscientific issues. Towards that end, this discussion will frame the affective domain in terms of specific components: emotion and mood. Although some research does not distinguish between these classes of affect, it seems likely that the two constructs can impose divergent influences (Ganzel, 1999; Forgas, 1995). Mood refers to relatively low level affective states with no single or immediate antecedent; therefore, it involves little or no cognitive content. People do not usually think about how factors contribute to their moods. Mood is generally conceptualized on a positive to negative continuum. Emotion, on the other hand, is usually an intense affective response to specific events. Emotion involves more cognitive effort because it is the content of thought that causes

the emotion (Ganzel, 1999). In the consideration of morality, two types of emotion can be differentiated: moral emotions and nonmoral emotions. The former class refers to those emotions which influence morality and can be determined by reactions to moral stimuli (Hoffman, 2000; Eisenberg, 2000). Mood and emotion will be considered independently as possible affective influences on socioscientific decision-making processes.

Moral Emotions

The moral emotions include two general classes: guilt and shame, and empathy and sympathy. Guilt emerges from an agent's recognition of moral transgressions. An agent feels guilty when he/she accepts responsibility for behavior that violates the normative moral standards of his/her culture. Shame is related to guilt in that it is a negative emotional state, but whereas guilt results from an internal assessment of behavioral transgressions, shame is an indictment of the self. An agent feels shame when he concludes that he fails to attain the societal standard (as opposed to an isolated behavioral incident). Given the ontology of these emotions, it is reasonable to assume behaviors and situations that inspire guilt and shame will be avoided by an agent who recognizes the relationship (Eisenberg, 2000). Empirical investigations support this intuitive claim by documenting the avoidance of moral transgressions in response to guilt and shame and in both children (Fergusen, Stegge, Miller, & Olsen, 1999) and adults (Tangney, Wagner, Hill-Barlow, Marschall, & Gramzow, 1996).

The other moral emotions, sympathy and empathy, are considered positive because rather than behavior avoidance, they encourage the adoption of certain behaviors. Empathy and sympathy are affective responses resulting from one agent's recognition and appreciation for the experience of another. In the case of empathy, the agent assumes an emotional state analogous to the individual who is actually experiencing crisis. Sympathy occurs when the agent feels for

the person in a distressful situation but does not share the same emotions. In either case, this type of emotional response can influence the manner in which individuals respond to moral situations and decisions. Mounting empirical evidence has documented the association between empathy (and sympathy) and prosocial behavior, an aspect of morality (Eisenberg, 2000; Trobst, Collins, & Embree, 1994; Batson, 1998).

The moral emotions just described have essentially been defined in the literature within the context of prosocial moral reasoning, which is distinct from moral reasoning as conceptualized in the cognitive-developmental tradition. Most of the empirical work that forms a basis for understanding the role of emotion in morality has involved research scenarios in which subjects negotiate prosocial dilemmas. Eisenberg-Berg, who has made significant contributions to this literature base, presents the following definition:

> [prosocial moral reasoning is] reasoning about conflicts in which the individual must choose between satisfying his or her own wants or needs and those of others in contexts in which laws, punishments, authorities, formal obligations, and other external criteria are irrelevant or deemphasized. (Eisenberg-Berg, 1979, p. 128)

It is not difficult to quickly conclude that socioscientific issues, the chief concern of this paper, are typically not congruent with prosocial moral reasoning. As agents contemplate socioscientific issues, they usually are not forced to consider personal sacrifice as a component of satisfactory resolution. In addition, prosocial dilemmas, as represented in the literature and articulated above, involve interpersonal relationships which are contexts quite dissimilar from those characterized by socioscientific issues. What then is the rationale for including a discussion of moral emotions as revealed through prosocial dilemmas in the treatment of socioscientific decision-making?

The standing question possesses a few answers. First, developing a theoretical framework for a problem, in this case the affective components of socioscientific decision-making, requires an examination of the empirical findings that exist. Prosocial dilemmas are not identical to socioscientific issues, but both reside in the moral domain, and the role of emotions in any type of moral decision-making provides a starting point. The fact that emotions do influence moral decisions and behavior in prosocial settings suggests that they may also influence other moral contexts. Second, work on moral emotions has begun to permeate areas of moral research beyond prosocial contexts; these findings will be explored later in the paper. Finally, one of the results of Gilligan's (1982) research is an appreciation for the orientation with which an individual approaches a particular moral dilemma. Pre-Gilligan interpretations of moral reasoning assumed that the reasoner occupied himself with the impersonal, principle-based aspects of a moral dilemma. For instance, an individual considering Kohlberg's famous Heinz dilemma should be concerned with property rights versus the sanctity of human life. Gilligan challenged this assumption by suggesting a relational orientation to the dilemma as opposed to the abstract, impersonal orientation offered in the previous example (Tronto, 1987; Noddings, 1984). From this perspective, an individual challenged with the same dilemma might focus on Heinz's feelings for his wife and her needs. The same kind of extension may be drawn to the orientation with which an individual perceives socioscientific issues. In its formal presentation, the debate over cloning does not appear to be laden with interpersonal issues; however, it is entirely plausible that an agent think about cloning not in terms of ethical principles governing the creation of life but how the procedure will affect individual lives. For example, this agent might consider the plight of a childless couple desperate for their own family. In light of Gilligan's (1982) contributions, making assumptions about how people perceive moral issues is

an empirically dangerous proposition which suggests that drawing a distinction between prosocial dilemmas and socioscientific issues may restrict the ability to understand how individuals negotiate the latter.

Moral Emotions Beyond Prosocial Morality

One method of discovering the components of morality, including the role of emotion, is to ask the agents and definers of morality. Morality is a social construction; therefore, individuals who create societies and their moral codes become a reasonable source for collecting data about the nature of moral systems. Walker and Pitts (1998) employed this rationale for the design of a series of studies to determine naturalistic conceptions of morality. In their first study, they asked 120 adults in three distinct age groups (17-24, 35-55, and 65-91), most of whom were both Caucasian and Christian, to identify characteristics of moral individuals. The respondents noted many character traits such as principled, loyal, caring, and fair, some of which, such as caring, are related to emotional responses. In a follow-up study involving 120 different individuals from relatively similar age and demographic groups, participants assessed the character traits offered in the initial experiment with respect to morality by means of a Likert scale instrument. Researchers analyzed these data to produce a rank order of the character traits that are most central to morality. The traits most strongly associated with morality were those that derive from an ethic of justice. Examples of these traits include 'concern for doing right', 'has clear values', and 'able to distinguish right/wrong'. Respondents suggested that traits associated with positive moral emotions such as 'caring', 'considerate', and 'thoughtful' were significantly less important for morality (Walker & Pitts, 1998).

The results of this study seem to suggest that the authors of morality, the people who live by current moral norms, are much less likely to define morality in terms of emotion than they are

principles. However, it is important to note the nature of the study itself; the authors did not experimentally confirm the degree to which the participants actually relied on the traits they cited or rated. Therefore, the conceptions of morality offered by the participants identify factors people think *should* contribute to resolving moral issues, not necessarily factors which *do* contribute. The fact that individuals frequently referenced emotion-based characteristics as moral indicators is a more significant finding than the ranking scheme. It leads to the conclusion that the individuals charged with resolving moral issues consider empathetic and sympathetic considerations to be important, as suggested by the researchers in the following quote. '[The] highly moral person is characterized by an other-oriented compassion and care that entails helpful, thoughtful, and considerate action and the nurturing of relationships through faithfulness and reliability' (Walker & Pitts, 1998, p. 415).

Other researchers have sought more direct evidence for the influence of emotions. Batson and his colleagues have designed research scenarios in which emotional influences have been revealed in moral decision-making processes (Batson et al., 1999; Batson, Klein, Highberger, & Shaw, 1995). In one study, the researchers asked 60 female college students to allocate a gift certificate to one of two others, who remained unknown (and were actually nonexistant). The subjects were randomly assigned to one of three treatment groups: a control group, a 'low empathy' group, and a 'high empathy' group. The control group was given no specific guidelines; whereas, the treatment groups read a note that was supposedly written by one of the potential recipients. The note detailed a very trying and stressful week and suggested that the author really needed 'something good to happen'. Researchers instructed the low empathy group to read the note without becoming partial, but they encouraged the high empathy group to adopt the perspective of the supposed author. Participants in both the control and low empathy groups

distributed the gift certificate equally among the potential recipients, but individuals in the high empathy group were three times as likely to give the gift certificate to the letter writer. In follow-up interviews, the high empathy group reported that their decision was based on care or concern for the letter writer, but over 90% of participants in all groups, including the high empathy group, reported that random determination would have been the most fair and moral. High empathy subjects were able to articulate a justice-oriented conception of the scenario (viz. both fictitious recipients held equal claims to the gift certificate and the determination should therefore be random); however, the affective reactions they experienced led a significant portion to a course of action inconsistent with justice principles (Batson et al., 1995).

The sample used in the previous experiment could be a source of contention because the issue of emotional influences is suffused with gender concerns. However, a follow-up study using 30 male and 30 female college student volunteers confirmed reliance on empathy as a primary determinant of moral behavior in both sexes. The participants read a scenario that described an organization, which offered treatment and comfort to terminally ill children. The organization had a waiting list because their resources could not match demand. The participants were asked to view a video of one child requesting services and to decide whether or not this child should be placed at the top of the waiting list. As in the first experiment, the researchers attempted to manipulate emotional regulation by instructing half the sample to try to maintain an objective perspective and the other half to try to 'imagine how the child … feels about what has happened …' (Batson et al., 1995). During subsequent interviews respondents showed cognitive awareness that it would be unfair to move a child ahead of others on the waiting list especially considering that they had only heard from one child. However, 27% of the low empathy females, 40% of the low empathy males, and 73% of both high empathy males and females

decided to move the child up the waiting list. This study provides clear examples of how empathy, a moral emotion, can determine moral action even when the actors have the ability to apply contradictory justice principles (Batson et al., 1995). These findings are supported by a similar study also based on the allocation of limited resources by the same research group (Batson et al., 1999).

Affect as Moral Motivation

In the course of studying development and cultural transmission of empathy, Hoffman (2000) has proposed important ideas about the role of affect in moral situations. In Hoffman's model, empathy and other-related emotions serve as primary moral motivators rather than passive reactions in response to certain situations. In other words, affect identifies the situations which require moral reasoning, decisions, or behavior (Gibbs, 1991). Many researchers have chronicled the disjunction between moral reasoning and the behaviors that follow; agents that have the ability to reason postconventionally fail to choose congruent actions (Arnold, 2000; Carpendale, 2000; Emler, 1996; Partington, 1997). Bersoff (1999) offers an explanation of this phenomenon by suggesting that in order to engage in moral reasoning, an agent must perceive the issue as a moral dilemma. Empathic motivation could be the mechanism by which agents perceive issues to be moral; their emotional responses to the situation signal whether the issue lies in the moral domain and therefore requires moral reasoning or not.

An alternative application of Hoffman's moral empathy model suggests that affect plays a stronger role in decision-making than just confirming that an issue requires moral reasoning. In this formulation, affect determines judgment and behavior. Once an agent develops a mature empathic disposition, which usually occurs in late childhood or adolescence (Hoffman, 1990), cognition and emotions are coordinated to such an extent that an agent's affective reaction

determines how he/she will respond to the situation (Gibbs, 1991; Hoffman, 2000). In this model, cognition is important for the interpretation of the situation and the stimulation of emotion. The results from a study of socioscientific decision-making provide at least tangential support for this interpretation. Researchers queried middle school students about how they arrived at decisions in reference to recycling issues. The responses appeared not to describe factors that led to their decisions; instead, they looked like justifications for decisions that had already been predetermined. Students did not use rational processes to arrive at a decision as suggested by the cognitive-developmental approach; they secondarily solicited rational arguments just to defend the decisions they had made based on some other criteria (Kortland, 1996). This study does not provide enough data to make definitive judgments about the role on emotion in this context; however, if individuals settle on decisions prior to engaging in formalized reasoning then emotion is a likely factor.

The research literature does not adequately address either of the 'affect as moral motivation' hypotheses just presented. In considering the two, a seminal question arises: do moral agents use affect to motivate reason-based decisions or do they use cognitive understanding to motivate emotion-based decisions? In either case, affect and cognition are inextricably interconnected, and attempts to explain morality in terms of one to the exclusion of the other are counter-productive (Gibbs, 1991; Nucci, 2001). In support of this contention, consider the following interview excerpt taken from a qualitative study of socioscientific argumentation (Zohar & Nemet, 2002). The speaker, a middle or high school student, explains his/her position on whether or not a couple should abort an embryo that may carry a debilitating disease.

> It depends. You need to find out whether the parents—Joseph and Rebecca are carriers and whether they transmitted the affected gene to their child. If they did not transmit the genes—there is no need for an abortion. But if they did—it is better to abort so that the baby and the family would not suffer. (p. 48)

Analyzing a single quotation without the benefit of further probing limits the analysis; however, it appears that this respondent combines logical calculations, such as the chance of gene transmission, with emotional considerations as evidenced by his/her empathic reaction to the family's potential suffering.

Situational Emotion: Mood

Early investigations of morality involved lengthy interviews during which participants responded to a series of hypothetical dilemmas. In order to shorten and standardize the process, Rest (1975) developed the Defining Issues Test. The DIT is a written instrument that also elicits responses to hypothetical dilemmas but can be completed in a relatively short amount of time and the scoring is significantly simpler than the interview format. The instrument has been validated as a reliable instrument for the assessment of moral reasoning (Rest, 1975; Rest et al., 2000). A logical place to look for affective influences on morality is an analysis of their effect on DIT scores. Olejnik and LaRue (1980) investigated how overall mood influenced DIT scores. They presented thirty-seven male and female college students with 50 statements followed by an administration of the DIT. One group of students read neutral statements, another read positive, and a final group read negative statements. The intent of each collection of statements was to stimulate mood differences among the participants; a test of affect following the experiment confirmed this result (i.e. participants who read positive statements had a more positive mood than those who had read either neutral or negative statements). Individuals with more positive

moods scored significantly higher than either of the other two treatment groups which were not statistically significantly different from one another. These results suggest that positive affective states are associated with more principled moral reasoning, as conceptualized by the cognitive-developmental approach (Olejnik & LaRue, 1980).

The DIT research is interesting given more recent findings presented in the literature on the effect of mood on decision-making in general. These studies do not specifically address moral decision-making, but their findings may be applicable. Results show that people in positive and negative moods react differently towards decisions. Positive mood states lead to the generation of more positive consequences in the contemplation of option outcomes, and they encourage the adoption of less rule-oriented heuristics. Agents with positive moods typically make decisions faster and more whimsically displaying less critical attention to detail. Negative mood states are associated with more careful deliberation and an increased use of available resources (Ganzel, 1999; Forgas, 1991). Forgas (1995) offers a hypothesis termed 'affect priming' to account for the effect of different mood states. Affect priming predicts that mood influences attention, cognitive encoding, and information retrieval. From the perspective of this hypothesis, people in good moods might be inclined to avoid taxing cognitive loads resulting in quick, whimsical decision-making.

Although all of the mood studies cited suggest a relationship between mood and decision-making, the Ganzel (1999) and Forgas (1991; 1995) findings seem to predict that agents in positive moods would tend to reason at lower levels in the cognitive-developmental scheme because they would be less likely to pay attention to critical details. These studies were not performed to address moral questions, but they do suggest potential problems for the earlier

research on mood and the DIT (Olejnik & LaRue, 1980). However, none of the reported research denies a role for mood influences on moral decision-making.

Conclusion

Theoretical Issues Associated with Emotions and Morality

From a philosophical perspective, the infusion of emotions in the moral domain creates problems because of two fundamental characteristics of emotions: the nondeliberate nature of emotion and the partiality of emotion (Ben-Ze'ev, 1997; Blasi, 1999; Pizarro, 2000). At their most basic level, emotions are bodily phenomena associated with involuntary physiological processes (Blasi, 1999). This seems to be inconsistent with most philosophical formulations which define morality as the deliberate evaluation and selection of alternative behaviors, beliefs, and decisions. However, psychological researchers and theorists suggest that despite their spontaneity, emotions can play a rational role in morality. Although individuals do not possess complete control of their emotional reactions, they do have the ability to regulate their emotions. Agents can employ deliberate strategies to control the influence that nondeliberate emotions have on their behavior and decision-making. Agents can learn to both cultivate and habituate emotions that may contribute to a better awareness of moral issues and situations. Regulated emotional responses can guide an agent in the evaluation of moral matters; agents can use a controlled emotion to gauge the morality of an event or situation as described by the 'affect as moral motivation' hypotheses. Emotions can become a type of standard that contributes to moral judgment (Ben-Ze'ev, 1997).

The other potential conflict between affect and morality is the partial nature of emotions. Emotions cause individuals to respond differently to similar situations based on the individuals involved (Ben-Ze'ev, 1997; Batson et al., 1995). If morality has an egalitarian aim as suggested

by philosophical interpretations, then partial emotions, which encourage moral responses to some others rather than all others, conflict with morality. While this may be a theoretical problem in situations in which the decision-maker is forced to choose between parties, not all moral scenarios fit this description. Consider again, the issue of gene therapy. An agent may empathize with friends who want to have children but fear passing on a deadly disease such as sickle cell anemia and therefore, decides to support germ-line gene therapy. By virtue of the agent's relationship with the subjects of her empathy, he/she displays partiality, but this fact fails to make her decision immoral. The partiality of emotions does not necessarily isolate them from the moral domain.

More important than the arguments presented here in opposition to the philosophical concerns regarding the nondeliberateness and partiality of emotion is the empirical evidence presented which supports the influence of emotion on moral decision-making. In their study of naturalistic conceptions of morality, Walker and Pitts (1998) showed that it is common for people to conceive morality as a construct that includes emotive concerns. Gilligan's (1982) work along with the work that resulted from it (Tronto, 1987; Noddings, 1984; Carse, 1996) have revealed that emotions associated with care contribute significantly to moral judgment and behavior. Batson and his colleagues (Batson et al., 1995; 1999) have produced experimental evidence to suggest that not only does emotion affect moral judgment, it can also preempt moral reasoning. Although the studies of mood do not yet reveal a singular interpretation for its role in moral decision-making, the results do suggest a likely influence. Finally, preliminary evidence supports Hoffman's (2000) hypothesis of emotional motivation of moral decisions and behaviors. While philosophers may have the luxury to consider the question of whether emotions *should* contribute to moral judgments, educators are faced with the fact that most of

their students *do* rely on emotions to arrive at decisions and courses of action concerning moral dilemmas including socioscientific issues. Therefore, ignoring emotions and the issues that stimulate them on the basis of theoretical objections or historically significant models of morality disservices science students and the society in which they participate.

Recommendations for Education and Research

Because affect and morality have not traditionally occupied science classrooms, the field of science education would benefit largely from research attention directed towards the extent to which emotions affect socioscientific decision-making as well as effective methodologies for the presentation of socioscientific issues in the classroom. It might be the case that students need to be made aware of affective influences on their decision-making so as to promote metacognitive awareness. This emotional awareness and regulation will enable students to confront their feelings about issues and utilize them in a manner consistent with their own agendas. It is too easy for students and adults alike to become overwhelmed by the emotions and other considerations associated with moral issues rendering them unable to make their own informed decisions. The solution to this potential problem is not disregarding emotions or training individuals to ignore their emotions; rather, informed decision-making requires an appreciation for emotive influences and the ability to integrate emotional motivation with other important factors. Part of this process must involve assessing the degree to which students understand particular issues. Individuals will be unable to experience moral emotions unless they possess enough content knowledge to negotiate complex socioscientific issues. For instance, agents cannot make empathy-based decisions with respect to gene therapy without a basic understanding of genetic diseases and the molecular basis of inheritance. Therefore, evaluating

student understanding and the effect of curricular materials on the development of moral emotion would be another fruitful area of research.

This report has made and supported several claims linking scientific literacy, socioscientific issues, morality and ethics, and affect. These associations dictate a necessary prescription for science education. The primary goal of science education is the promotion of scientific literacy, and socioscientific decision-making must be an integral component of this aim. Socioscientific issues involve morals and ethics; consequently, the negotiation of these issues must attend to these integral factors. Affect significantly influences the manner in which individuals perceive and generate resolution to moral issues. Therefore, instruction aimed at facilitating the development of socioscientific decision-making skills must involve the consideration of the affective components of ethics and morality. Curricular programs and research agendas aimed at improving scientific literacy need to further explore the emotive aspects of morality. If the goal of science education is the promotion of scientific literacy and scientific literacy involves the negotiation of socioscientific issues, then science educators must attend to emotional factors when designing science curricula because of the central role emotions play in shaping socioscientific decisions.

References

American Association for the Advancement of Science: 1990, *Science For All Americans*, Oxford University Press, New York

American Association for the Advancement of Science: 1993, *Benchmarks for Science Literacy*, Oxford University Press, New York

Arnold, M. L.: (2000), 'Stage, Sequence, and Sequels: Changing Conceptions of Morality, Post-Kohlberg', *Educational Psychology Review* (12), 365-383.

Batson, C. D.: 1998, 'Altruism and Prosocial Behavior', In D. T. Gilbert, S. T. Fiske, & G. Lindzey (Eds.), *The Handbook of Social Psychology,* McGraw-Hill, Boston, pp. 282-316

Batson, C. D., Ahmad, N., Yin, J., Bedell, S. J., Johnson, J. W., Templin, C. M., & Witeside, A.: (1999), 'Two Threats to the Common Good: Self-Interested Egoism and Empathy-Induced Altruism', *Personality and Social Psychology Bulletin* 25, 3-16.

Batson, C. D., Klein, T. R., Highberger, L., & Shaw, L. L.: (1995), 'Immorality from Empathy-Induced Altruism: When Compassion and Justice Conflict', *Journal of Personality and Social Psychology* 68, 1042-1054.

Bell, R. L., & Lederman, N. G.: (in press), 'Understandings of the Nature of Science and Decision Making on Science and Technology Based Issues', *Science Education* .

Ben-Ze'ev, A.: (1997), 'Emotions and Morality', *The Journal of Value Inquiry* 31, 195-212.

Bersoff, D. M.: (1999), 'Explaining Unethical Behaviour Among People Motivated To Act Prosocially', *Journal of Moral Education* 28, 413-428.

Blasi, A.: (1999), 'Emotions and Moral Motivation', *Journal for the Theory of Social Behaviour* 29, 1-19.

Carpendale, J. I. M.: (2000), 'Kohlberg and Piaget on Stages and Moral Reasoning',

Developmental Review 20, 181-205.

Carse, A. L.: 1996, 'Facing up to Moral Perils: The Virtues of Care in Bioethics', In S. Gordon, P. Benner, & N. Noddings (eds.), *Caregiving: Readings in Knowledge, Practice, Ethics, and Politics,* University of Pennsylvania Press, Philadelphia, pp. 83-110

Champagne, A. B., & Lovitts, B. E.: 1989, 'Scientific Literacy: A Concept in Search of Definition', In A. B. Champagne, B. E. Lovitts, & B. J. Callinger (Eds.), *This Year in School Science. Scientific Literacy,* American Association for the Advancement of Science, Washington, pp. 1-14

Charles, D.: 2001, *Lords of the Harvest: Biotech, Big Money, and the Future of Food*, Perseus Publishing, Cambridge, MA

DeBoer, G. E.: (2000), 'Scientific Literacy: Another Look at its Historical and Contemporary Meanings and its Relationship to Science Education Reform', *Journal of Research in Science Teaching* 37, 582-601.

Donenberg, G., & Hoffman, L.: (1988), 'Gender Differences in Moral Development', *Sex Roles* 18, 701-717.

Driver, R., Newton, P., & Osborne, J.: (2000), 'Establishing the Norms of Scientific Argumentation in Classrooms', *Science Education* 84, 287-312.

Eisenberg-Berg, N.: (1979), 'Development of Children's Prosocial Moral Judgment', *Developmental Psychology* 15, 128-137.

Eisenberg, N.: (2000), 'Emotion, Regulation and Moral Development', *Annual Review of Psychology* 51, 665-697.

Emler, N.: (1996), 'How Can We Decide Whether Moral Education Works?', *Journal of Moral Education* 25, 117-126.

Fergusen, T. J., Stegge, H., Miller, E. R., & Olsen, M. E.: (1999), 'Guilt, Shame, and Symptoms in Children', *Developmental Psychology* 35, 347-357.

Fleming, R.: (1986a), 'Adolescent Reasoning in Socio-scientific Issues, Part I: Social Cognition', *Journal of Research in Science Teaching* 23, 677-687.

Fleming, R.: (1986b), 'Adolescent Reasoning in Socio-scientific issues, Part II: Nonsocial Cognition', *Journal of Research in Science Teaching* 23, 689-698.

Ford, M., & Lowery, C.: (1986), 'Gender Differences in Moral reasoning: A Comparison of the Use of Justice and Care Orientations ', *Journal of Personality and Social Psychology* 50, 777-783.

Forgas, J. P.: 1991, *Emotion and Social Judgments: An Introductory Review*, Pergamon, Oxford

Forgas, J. P.: (1995), 'Mood and Judgment: The Affect Infusion Model (AIM)', *Psychological Bulletin* 117, 39-66.

Friedman, W., Robinson, A., & Friedman, B.: (1987), 'Sex Differences in Moral Judgments? A Test of Gilligan's Theory', *Psychology of Women Quarterly* 11, 37-46.

Ganzel, A. K.: (1999), 'Adolescent Decision Making: The Influence of Mood, Age, and Gender on the Consideration of Information', *Journal of Adolescent Research* 14, 289-318.

Gibbs, A. K.: (1991), 'Toward an Integration of Kohlberg's and Hoffman's Moral evelopment Theories', *Human Development* 34, 88-104.

Gilligan, C.: 1982, *In A Different Voice: Psychological Theory and Women's Development*, Harvard University Press, Cambridge, MA

Hekman, S. J.: 1995, *Moral Voices, Moral Selves: Carol Gilligan and Feminist Moral Theory*, The Pennsylvania State University Press, University Park, PA

Hoffman, M. L.: (1990), 'Empathy and Justice Motivation', *Motivation and Emotion* 14, 151-172.

Hoffman, M. L.: 2000, *Empathy and Moral Development: Implications for Caring and Justice*, Cambridge University Press, Cambridge

Hogan, K.: (2002), 'Small Groups' Ecological Reasoning While Making an Environmental management decision', *Journal of Research in Science Teaching* 39, 341-368.

Kohlberg, L.: (1973), 'The Claim to Moral Adequacy of a Highest Stage of Moral Judgment', *Journal of Philosophy* 70, 630-646.

Kohlberg, L.: 1985, 'A Current Statement on Some Theoretical Issues', In S. Mogdil, & C. Modgil (Eds.), *Lawrence Kohlberg: Consensus and Controversy*, The Farmer Press, Philadelphia,

Kolstø, S. D.: (2001a), 'Scientific Literacy for Citizenship: Tools for Dealing with the Science Dimension of Controversial Socioscientific Issues', *Science Education* 85, 291-310.

Kolstø, S. D.: (2001b), "To Trust or Not To Trust,...'-Pupils' Ways of Judging Information Encountered in a Socio-scientific Issue', *International Journal of Science Education* 23, 877-901.

Korpan, C. A., Bisanz, G. L., Bisanz, J., & Henderson, J. M.: (1997), 'Assessing Literacy in Science: Evaluation of Scientific News Briefs', *Science Education* 81, 515-532.

Kortland, K.: (1996), 'An STS Case Study About Students' Decision Making on the Waste Issue', *Science Education* 80, 673-689.

Laugksch, R. C.: (2000), 'Scientific Literacy: A Conceptual Overview', *Science Education* 84, 71-94.

Narvaez, D.: (1998), 'The Influence of Moral Schemas on the Reconstruction of Moral Narrative in Eighth Graders and College Students', *Journal of Educational Psychology* 90, 13-24.

National Research Council: 1996, *National Science Education Standards*, National Academy

Press, Washington

Noddings, N.: 1984, *Caring: A Feminine Approach to Ethics and Moral Education*, University of California Press, Berkeley, CA

Nottingham, S.: 1998, *Eat Your Genes: How Genetically Modified Food Is Entering Our Diet*, Zed Books, London

Nucci, L. P.: 2001, *Education in the Moral Domain*, Cambridge University Press, Cambridge

Olejnik, A. B., & LaRue, A. A.: (1980), 'Affect and Moral Reasoning', *Social Behavior and Personality* 8, 75-79.

Oser, F. K.: (1996), 'Kohlberg's Dormant Ghosts: The Case of Education', *Journal of Moral Education* 25, 253-275.

Partington, G.: (1997), 'Cultural Invariance and the Denial of Moral Regression: A Critique of Piaget and Kohlberg', *International Journal of Social Education* 11, 106-119.

Patronis, T., Potari, D., & Spiliotopoulou, V.: (1999), 'Students' Argumentation in Decision-Making on a Socio-scientific Issue: Implications for Teaching', *International Journal of Science Education* 21, 745-754.

Pedretti: (1999), 'Decision Making and STS Education: Exploring Scientific Knowledge and Social Responsibility in Schools and Science Centers through an Issues-Based Approach', *School Science and Mathematics* 99, 174-181.

Pence, G. E.: 2002, *Designer Food: Mutant Harvest or Breadbasket of the World*, Rowman & Littlefield Publishers, Lanham, MD

Piaget, J. (1948). The Moral Judgment of the Child. Glencoe, IL: Free Press.

Pizarro, D.: (2000), 'Nothing More Than Feelings? The Role of Emotions in Moral Judgment.', *Journal for the Theory of Social Behaviour* 30, 355-375.

Pool, R.: (1991), 'Science Literacy: The Enemy Is Us', *Science* 251, 266-267.

Rest, J.: (1975), 'Longitudinal Study of the Defining Issues Test of Moral Judgment: A Strategy for Analyzing Moral Change', *Developmental Psychology* 11, 738-748.

Rest, J. R., Narvaez, D., Bebeau, M. J., & Thoma, S. J.: 1999, *Postconventional Moral Thinking: A Neo-Kohlbergian Approach*, Erlbaum, Mahwah, NJ

Sadler, T. D., Chambers, F. W., & Zeidler, D. L.: (in press), 'Investigating the Crossroads of the Nature of Science, Socioscientific Issues, and Critical Thinking', *International Journal of Science Education* .

Singer, M. S.: (1999), 'The Role of Concern for Others and Moral Intensity in Adolescents' Ethicality Judgments', *The Journal of Genetic Psychology* 160, 155-166.

Snarey, J. R.: (1985), 'Cross-Cultural Universality of Social-Moral Development: A Critical Review of Kohlbergian Research', *Psychological Belletin* 97, 202-232.

Tangney, J. P., Wagner, P. E., Hill-Barlow, D., Marschall, D. E., & Gramzow, R.: (1996), 'Relation of Shame and Guilt to Constructive Versus Destructive Responses to Anger across the Lifespan', *Journal of Personality and Social Psychology* 70, 797-809 .

Thoma, S. J., & Rest, J. R.: (1999), 'The Relationship Between Moral Decision Making and Patterns of Consolidation and Transition in Moral Judgment development', *Developmental Psychology* 35, 323-334.

Trobst, K. K., Collins, R. L., & Embree, J. M.: (1994), 'The Role of Emotion in Social Support Provision: Gender, Empathy and Expression of Distress', *Journal of Social and Personal Relations* 11, 45-62.

Tronto, J. C.: (1987), 'Beyond Gender Difference to a Theory of Care', *Signs: Journal of Women in Culture and Society* 12, 644-663.

Tytler, R., Duggan, S., & Gott, R.: (2001), 'Dimensions of Evidence, the Public Understanding of Science and Science Education', *International Journal of Science Education* 23, 815-832.

Walker, L. J., & Pitts, R. C.: (1998), 'Naturalistic Conceptions of Moral Maturity', *Developmental Psychology* 34, 403-419.

Walker, L. J., & Taylor, J. H.: (1991), 'Stage Transitions in Moral Reasoning: A Longitudinal Study of Developmental Processes', *Developmental Psychology* 27, 330-337 .

Zeidler, D. L.: (1984), 'Moral Issues and Social Policy in Science Education: Closing the Literacy Gap', *Science Education* 68, 411-419.

Zeidler, D. L., & Schafer, L. E.: (1984), 'Identifying Mediating Factors of Moral Reasoning in Science Education', *Journal of Research in Science Teaching* 21, 1-15.

Zeidler, D. L., Walker, K. A., Ackett, W. A., & Simmons, M. L.: (2002), 'Tangled up in Views: Beliefs in the Nature of Science and Responses to Socioscientific Dilemmas', *Science Education* 86, 343-367.

Zohar, A., & Nemet, F.: (2002), 'Fostering Students' Knowledge and Argumentation Skills Through Dilemmas in Human Genetics', *Journal of Research in Science Teaching* 39, 35-62.

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